Origin of the anomalous spin resonance in a strongly correlated electron system

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The physics of strongly correlated low-dimensional electronic systems remains a focal point of the modern condensed matter research. The semiconductor material systems, such as ZnO/MgZnO heterojunction, boast of the large values of effective mass m^* that lowers the gap between Landau levels, so that the many-particle correlations contribute significantly to the physics of the system. Large mass of electrons inevitably complicates the theoretical description of the system leaving only rather limited theoretical approaches based on exact diagonalization, guessing the screening functions or phenomenological renormalization of band parameters. As a result, many of the beautiful effects observed experimentally are still poorly understood. One of such puzzles is the non-trivial spin properties of the strongly correlated two-dimensional electron system both at small magnetic field and in the regime of quantum Hall effect (QHE). Present work aims to considerably extend the experimental knowledge by probing the spin properties of the two-dimensional electron system by means of electron spin resonance (ESR), in case the many-particle correlations dominate the characteristic energy associated with the kinetic motion of electrons.

In present work we study the origin of the anomalous spin resonance detected electrically in a strongly correlated two-dimensional electron system [1]. Such resonance reveals itself around nominally non-magnetic even filling factors ν of the integer quantum Hall effect and is a consequence of strong electron-electron interactions. We directly demonstrate that while the spin resonance at odd ν manifests itself as an increase in the longitudinal resistance of the 2D channel induced by the usual heating due to the radiation absorption, the anomalous resonance around even fillings is detected as a drop in the resistance, as if the electron system is cooled. In contrast, if the magnetic field is tilted so that the ground state of the system becomes ferromagnetic at even ν, the spin resonance around even fillings turns to a more conventional "heating"-like behavior. Analysis of both the evolution of the spin resonance with increasing tilt angle and the measured temperature dependencies allowed us to put forth a possible mechanism of anomalous spin resonance around even fillings that qualitatively explains all of the puzzling experimental findings [2,3].

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[3] A. V. Shchepetilnikov, A. R. Khisameeva, Y. A. Nefyodov, and I. V. Kukushkin, Electron spin resonance under conditions of a ferromagnetic phase transition, *JETP Letters 113*, **657** (2021).